Azimuthal Dependence of the $\langle p_T \rangle$ Fluctuations

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The event by event mean transverse momentum fluctuations, which have been proposed as one of the signatures to identify the critical point for the phase transition from ordinal matter to quark-gluon-plasma [1], have been the focus of many studies in heavy ion collisions [2–5]. The event by event $\langle p_T \rangle$ fluctuations also can supply us some information about the system dynamical evolution and particles production mechanism which can not be extracted from the inclusive p_T spectra.

In the non-centrality Au+Au collisions, the strong final state interactions and particles spacial asymmetry distribution will lead to the elliptic flow which have been observed in experiments [6]. The p_T dependence of elliptic flow will lead to the anisotropic distribution of $\langle p_T \rangle$ with respect to the event plane. For example , the $\langle p_T \rangle$ will be bigger in the azimuthal region near the event plane compared with that away the event plane. It will lead to extra $\langle p_T \rangle$ fluctuations from the inclusive $\langle p_T \rangle$ event by event.

To calculate this extra $\langle p_T \rangle$ fluctuations induced by elliptic flow. We define two fixed directions including in-plane and out-of-plane and one random direction with respect to the event plane. The in-plane is defined in the direction of the event plane angle($|\phi_i - \phi_R| < \pi/4$ and $|\phi_i - \phi_R| > 3\pi/4$) and the out-of-plane is defined in the direction which is perpendicular to event plane (out-of-plane, $\pi/4 < \phi_i - \phi_R| < 3\pi/4$), where the ϕ_i is the azimuthal angle of charged hadron and the ϕ_R is the angle of reaction plane. The random direction is defined as $|\phi_i - \phi_{Random}| < \pi/4$ and $|\phi_i - \phi_{Random}| > 3\pi/4$. The ϕ_{Random} is randomly chosen in each event.

We use the $\langle p_T \rangle$ fluctuations function of $\langle \Delta p_{Ti}, \Delta p_{Tj} \rangle$ as the measurement [7]. As the Fig1 shown, the elliptic flow effect will enhance the $\langle \Delta p_{Ti}, \Delta p_{Tj} \rangle$ in the random direction. This effect is strongest at $N_{part} = 150 \sim 200$ and about 80% of $\langle p_T \rangle$ is caused by the elliptic flow. To the peripheral collision, the correlations between the particles is week, so the elliptic flow effect is weak. And to the central collision, the eccentricity of $\langle p_T \rangle$ is smallest and the elliptic flow effect is small too.

In summary, we reported the azimuthal dependence of the $\langle p_T \rangle$ fluctuation, as a function of collision centrality, from the 200 GeV Au+Au collisions. We observed that there is a significant increase in $\langle \Delta p_{Ti}, \Delta p_{Ti} \rangle$ in the random case compared with the case where the reaction plane was fixed. This suggests that the rapid change in the $\langle p_T \rangle$ fluctuation with centrality is mainly caused by the elliptic flow. Effects of jet-quenching [4] or percolation [8] may not be the dominant source for the observation.

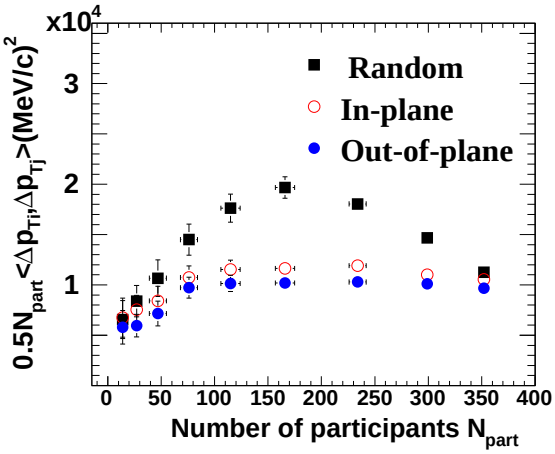

FIG. 1: The panel a) is the $0.5 N_{part} \langle \Delta p_{Ti}, \Delta p_{Tj} \rangle$ as a function of number of participants in the fixed directions of in-plane and out-of-plane and random direction.The $\langle \Delta p_{Ti}, \Delta p_{Tj} \rangle$ is calculated in the p_T range $0.2 GeV/c < p_T < 2.0 GeV/c$ and $|\eta| < 1.0$.

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